

MARKETING SHEET MICA

BY ROBERT D. THOMSON

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CONTENTS

	<u>Page</u>
Introduction	1
Acknowledgments	1
Mineralogy	1
Physical defects	2
Structural imperfections	2
Impurities	3
Preparation	3
Classification	5
Grading	5
Qualifying	8
Color	11
Marketing	13
Production and consumption	13
Uses	13
Buyers of sheet mica	15
Government mica programs	15
Prices	19

TABLES

1. Grades (sizes) of muscovite block and film mica	5
2. Classification of muscovite splittings	7
3. Quality classification of muscovite block mica, 0.007 inch, minimum thickness based on visual properties	9
4. Electrical, physical, and visual quality requirements of natural block and film mica for use in capacitors	12
5. Fabrication of muscovite ruby and nonruby block and film mica, by quality and endproduct use in the United States, 1953	14
6. Fabricators of block and film mica	16
7. Producers of built-up mica (consumers of mica splittings)...	16

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Information Circular 7729

TABLES (Con.)

	<u>Page</u>
8. Importers of sheet mica	17
9. Prices for various grades and qualities of sheet mica in North Carolina district, 1955	19
10. Domestic-mica-purchasing program (GSA) prices per pound, ruby and nonruby block and film mica	19

ILLUSTRATIONS

Fig.

1. American Society for Testing Materials chart for grading natural muscovite block and film mica	6
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INTRODUCTION

Sheet mica is an important material in the manufacture of electronic and electrical equipment. Large quantities are consumed each year as an essential component in generators, transformers, radios, television sets, radar, electric lighting equipment, and electrical appliances. The nature, structural imperfections, and impurities determine to a great degree the usefulness of sheet mica. Proper processing and classification add greatly to its market value. This report is designed to assist producers in understanding the complexities of marketing muscovite sheet mica.

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MINERALOGY

Minerals of the mica group are complex hydrous potassium aluminum silicates. They often contain magnesium, ferrous iron, and fluorine, and some varieties contain sodium, lithium, chromium, titanium, barium, and manganese. The exact composition of many of the micas is not known; however, the following formulas show the approximate compositions of the typical species in the mica group:

<u>Species</u>	<u>General formula^{1/}</u>
Muscovite	$H_2KAl_3(SiO_4)_3$
Phlogopite	$H_2KMg_3Al(SiO_4)_3$
Biotite	$H_2K(Mg, Fe)_3Al(SiO_4)_3$
Lepidolite	$(OH, F)_2KLiAl_2Si_3O_{10}$
Lepidomelane	$HK_2F_3^{II}Fe_6^{III}Al_3(SiO_4)_9$
Paragonite	$H_2NaAl_3(SiO_4)_3$
Roscoelite	$H_8K(Mg, Fe)(Al, V)_4(SiO_3)_{12}$
Zinnwaldite	$(K, Li)_3FeAl_3Si_5O_{16}(OH, F)_2$

^{1/} Slight differences in composition give rise to numerous varieties.

A chemical analysis of mica is not significant because analyses can vary widely and usually bear little relation to the electrical or physical properties.

The micas crystallize in the monoclinic system and usually are orthorhombic or hexagonal in symmetry. All species are characterized by almost perfect basal cleavage, which permits splitting into thin sheets or laminae. Of the five commercial micas, muscovite, phlogopite, and biotite are used because of their physical properties, and lepidolite and roscoelite are mined for their lithium and vanadium content. Muscovite, the potash mica, is the major mica mineral produced in the United States and is of strategic importance. Discussion of mica in this report is limited to muscovite sheet mica.

Muscovite has an eminent basal cleavage and a secondary cleavage, which cuts the crystals at angles of 60° to 70° with the basic cleavage. The secondary cleavage may extend entirely through the crystal or only part of the way, either across the cleavage face or through the thickness of the crystal. Mica showing a secondary cleavage is called ruled mica. Owing to its basal cleavage, muscovite can be split into thin sheets or laminae less than one thousandth of an inch thick. The sheets are tough, elastic, transparent, flexible, and colorless when split to less than one-thirty-second of an inch. Thicker sheets may be colorless, pinkish buff, drab, brown, green, or red. Muscovite mica ranges in hardness from 2 to 2.5 on Mohs' scale, and has a specific gravity of 2.76 to 3 and a vitreous luster. It is insoluble in acids and will resist decomposition up to 400°C . At 700°C it loses about one-tenth of 1 percent of its weight.

PHYSICAL DEFECTS

Structural Imperfections

Structural imperfections determine to a great degree the commercial usefulness of sheet mica. Reasonable flatness is of fundamental importance in sheet mica, but mica that is optically flat is extremely rare. Reeves, warping, wedging, and ruling are terms for imperfections that prevent flatness.

Reeves, also known as cross-grains, are lines, striations, corrugations, or folds arising from innumerable partings across the basal cleavage. Reeves can be simple, closely spaced folds or complex, broadly spaced corrugations. If the distance between the lines or the space between the missing laminae is small (narrow), the reeves appear as fine lines; if laminae are missing over a greater space, reeves are a combination of corrugations and edges of incomplete laminae. "A" mica contains two series of rulings or striations intersecting at an angle of about 60° . The third series of striations necessary to form the letter A are not present, and the intersecting reeves form a V. Typical "A" mica will have the reeves extending across the entire sheet and the apex near one edge. The area between the rulings of the "A" is frequently of good physical quality. Herringbones (fishbones, fishbacks, horsetails, or feathers) are numerous reeves that intersect to form a series of V's, the legs making an angle of 120° at the apex. These reeves usually flank a central reeve to form a pattern resembling a fish skeleton.

Buckles, waves, and ridges are terms used to describe the degree of warping. A buckle is a single concave depression in the middle of the sheet; waves are a series of alternate elevations and depressions; and ridges or ribs are parallel crenulations in the form of steps.

Wedge mica is, as the name implies, wedge-shaped and, on splitting, yields pieces of mica thicker on one side than the other. This structure is caused by the interlayering of laminae of unequal size. Wedge mica commonly has "A" or herringbone imperfections and is referred to as "wedge-A" compared to "flat-A." Wedge mica is not satisfactory for use as sheet mica and usually can be used only as scrap mica.

Ruled or ribboned mica has parallel fractures or parting planes intersecting the basal cleavage plane at about 60°. These planes cause the mica to break into narrow strips. Books of mica can have one or more sets of fracture planes, which may pass completely or only partly through the mica.

Irregular visible cracks in the mica caused by nature or by blasting and rough handling often are present. Haircracks (hairline cracks) are minute cracks that rarely are noticeable until the mica is split and then they cause torn laminae or films.

The name tangle-sheet is applied to mica having intergrowths of individual laminae. Part of this mica often splits well; other parts will tear.

Impurities

The presence of visible mineral and vegetable impurities decreases the value of the mica. The most common imperfections resulting from impurities are stains impregnating the crystals along their cleavage planes. Staining may be caused by air bubbles, clay, iron and manganese compounds, organic matter, or a combination of two or more of these impurities in the form of specks or patches restricted to one part of the sheet or extending over the entire surface. Stains are either intergrowths and inclusions between the laminae or impurities contained in the crystal structure. Infiltrated stains can be removed by careful splitting or trimming, but there is no known method for removing crystallized stains. Mineral stains may be black, red, brown, or green, and stains caused by organic matter, commonly called vegetable stains may be yellow, green, or brown. Inclusions are of either mineral or gaseous origin. Air inclusions appear as small bubbles in clusters or pockets. When viewed by reflected light air stains appear silvery in color; when viewed by transmitted light they appear grayish. Mineral inclusions are usually dark, and some of the minerals that may penetrate the mica sheets are albite, beryl, biotite, columbite, fluorite, garnet, hematite, quartz, rutile, topaz, and tourmaline.

Stains are not the sole criteria for classifying sheet mica into quality groups, such as, Good Stained, Stained, etc. Other impurities and structural imperfections, as shown in table 3, determine the quality groups.

— PREPARATION

Preparation of sheet mica for market depends solely on hand methods and human judgment. Minor imperfections, inclusions, rough edges, and defective laminae are removed by cobbing, rifting, and trimming. Quality and grade usually are judged visually. Man is limited in his efforts to improve the quality and grade of mica and nature is the controlling factor.

Preparation of sheet mica for market consists of (1) cobbing, (2) rifting, (3) trimming, and (4) classifying as to quality and grade (size).

As obtained from the mine, crude mica is in the form of crystals or rough books of various shapes and sizes and is known as mine run, run-of-mine, book, or block mica. The term "block" normally is used for prepared mica and should not be considered as a term for crude mica directly from the mine. The rough books are first cobbled to remove all adhering rock, dirt, and crushed mica. During cobbing, defective mica is segregated from the books that will yield usable sheet mica. The resultant usable rough mica is called hand-cobbed mica.

The hand-cobbed mica next is rifted or split. A straight-bladed knife usually is used in the United States for rifting. The products of the rifting operation are broadly classified as untrimmed sheet mica and scrap mica.

Basically, sheet mica is any mica that is relatively flat and free enough from physical defects to enable it to be punched or stamped into specified shapes. More specifically, sheet mica is classified as block, film, and splittings, based on the thickness and quality of the mica. Block mica is mica not less than 0.007 inch thick with a minimum usable area of 1 square inch. Film mica is split from the better qualities of block mica to a specified range of thicknesses, such as 0.00125 to 0.002, 0.002 to 0.003, and 0.003 to 0.004 inch. Splittings are sheets with a maximum thickness of 0.0012 inch. Mica 0.002 to 0.004 inch thick is called thins and 0.004 to 0.007 is called thick thins. Small sized, low-quality block mica is subdivided as punch, circle, and washer. Punch mica is thumb-trimmed material sufficient in area to yield a circular disk at least 1-1/2 inches in diameter for Stained quality mica and 1-1/4 to about 2 inches for Clear quality. Circle mica is an old term for mica larger than punch that yields sheets about 2 inches in diameter. Miners often sorted out a class of mica ranging between punch and a 1-1/2- by 2-inch grade that was known as circle or toaster mica. The poorer lots of punch mica often are referred to as washer mica. Usually, the term "punch mica" is used to include punch, circle, and washer mica.

Trimming, the next step in processing block and film mica, removes broken and ragged edges, loose scales, and any other major imperfections. Trimming may be done using a knife, sickle, shears, or fingers. In the United States, trimming usually is done with a single 3-inch blade linoleum knife to produce a beveled-edged cut. The trimmer tries to follow the natural contour of the mica. If ragged edges of the rifted mica are broken off with the thumb and fingers, it is called thumb-trimmed mica. Half-trimmed mica is rifted mica trimmed on two adjacent sides, with at least two-thirds of the mica trimmed and no cracks extending into the usable area. Full-trimmed mica is rifted mica trimmed on all sides with all cracks, reeves, and cross grains removed.

Large quantities of apparently usable high-quality, large sheet mica are ruined by improper rifting and over trimming. Care should be taken in rifting and trimming to determine what parts of the mica should be removed to obtain the maximum usable area and minimum waste. In normal times domestic producers can only thumb trim or half trim mica because the labor costs for a better trim are excessive. Every attempt should be made to obtain as good a trim as possible because the better the trim, the better the price that will be obtained. Frequently, however, the miner will find that he can obtain a greater return by selling rough-trimmed or half-trimmed mica because the greater weight more than offsets the higher price per pound for better prepared mica. Essentially, it has been profitable only to full-trim mica for sale to the Government. It takes experienced rifters and trimmers to obtain the proper yield from mine-run mica and an inexperienced worker can ruin the usable mica sheet. An experienced worker will salvage punch and even block from material that less experienced workers would discard. However, regardless of the

method used or the precautions taken, sizable quantities of scrap (referred to as bench-scrap or trimming-shop scrap) are produced.

Classification

No mineral is as difficult to classify as mica or approaches the multiplicity of qualities and grades (sizes) into which mica is classified. The best overall standard for block and film mica is American Society for Testing Materials Specifications (ASTM) D 351-53T; the best for splittings is National Electrical Manufacturers Associations Standards.

Grading

Trimming produces block or film mica of irregular shapes and sizes, and the mica must be classified according to grade (size). A standard grading system for trimmed muscovite block or film mica is based on the maximum usable rectangle that can be punched or stamped from the piece of mica. Grades are universal, but several countries use different designations, as shown in table 1. Using ASTM specifications, block and film mica can be classed into 12 grades, ranging from the smallest, No. 6, to the largest, OOE Special. Figure 1 can be used for grading mica. The mica to be graded can be placed upon the chart so that it covers point O and has its maximum and minimum dimensions along the lines OA and OB. The specimen should be moved until the usable area completely covers the largest rectangle, as determined by an imaginary diagonal line extending from O to any point on any of the curves. The number of the curve, such as No. 4, in which the diagonal of the rectangle terminates will represent the grade number. Four grades larger than those shown in figure 1 are listed in table 1.

TABLE 1. - Grades (sizes) of muscovite block and film mica

Area of minimum rectangle, square inches	Grade (size) classification					Minimum dimensions on one side, inches
	ASTM	United States, domestically produced mica	Madagascar	India	Brazil	
100	OOE Special	8 x 12	0000	OOE Special	OEE Special	4
80	OEE Special	8 x 10	000	OEE Special	EE Special	4
60	EE Special	6 x 10	00	EE Special	E Special	4
48	E Special	6 x 8	0	E Special	Special	4
36	A1 Special	6 x 6	A1	Special	A1	3-1/2
24	1	4 x 6	1	1	1	3
15	2	3 x 5	2	2	2	2
10	3	3x3 & 3x4	3	3	3	2
6	4	2 x 3	4	4	4	1-1/2
3	5	1-1/2x2 & 2x2	5	5	5	1
2-1/4	5-1/2	Circle	6	5-1/2	5-1/2	7/8
1	6	Punch	6	6	6	3/4

Virtually no mica splittings are produced in the United States. Grades for mica splittings are determined by the area of usable rectangle and minimum dimension of one side of a rectangle. In accordance with NEMA Standards for Manufactured Electrical Mica, as shown in table 2, book form and loose form splittings comprise 3 grade categories, and loose with powder form comprises 4 grades.

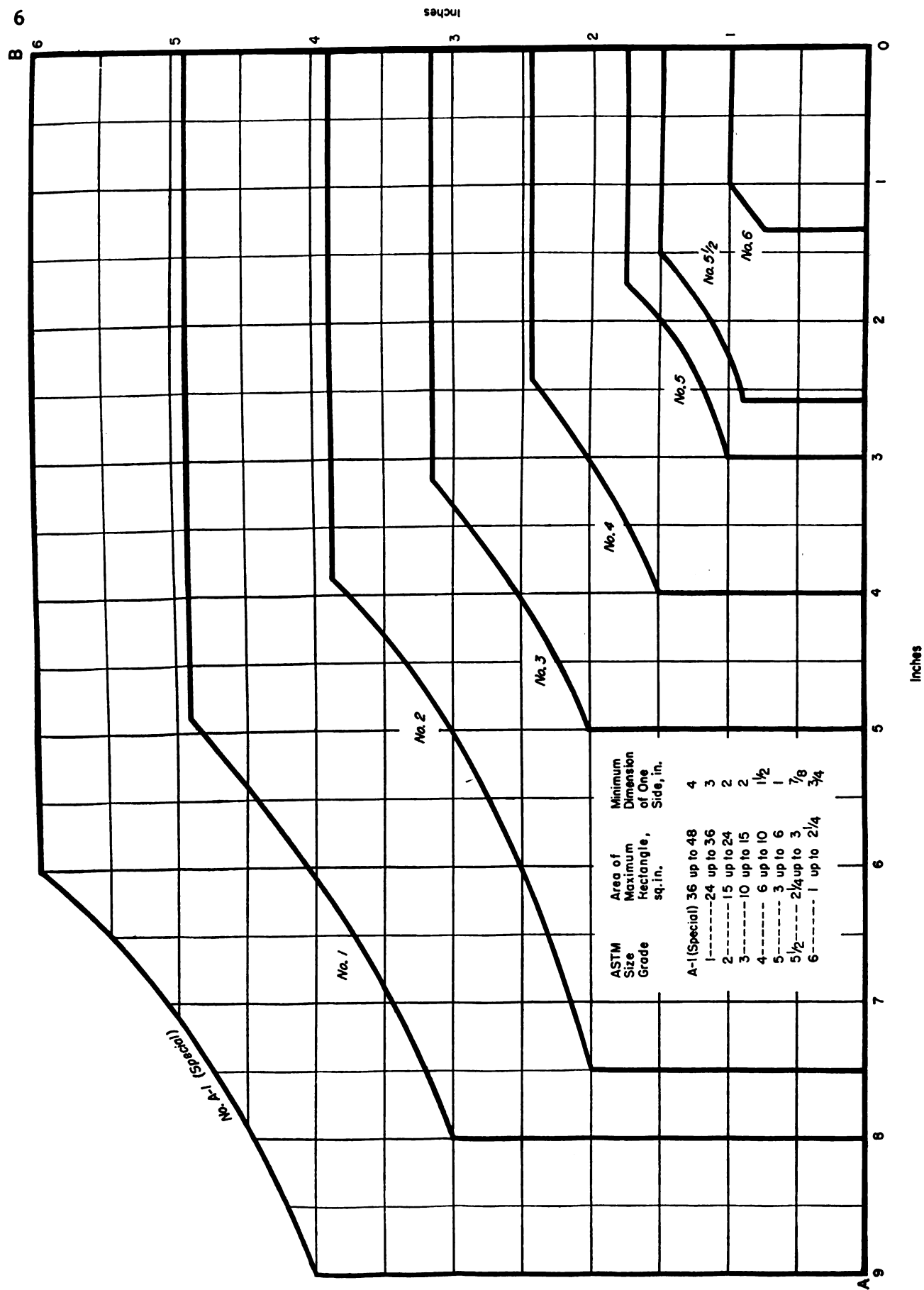


Figure 1. - ASTM chart for grading natural muscovite block and film mica.

TABLE 2. - Classification of muscovite splittings^{1/}

NEMA grade	Form ^{2/}	Size, ^{3/} sq. in.	Minimum dimension of usable rectangle, in.	Thickness per 10 splittings, in.	Remarks
AA...	Book form (1).. Loose with powder (2)....	6 up to 10	1-1/2	0.006 to 0.009 incl.	(1) Splittings shall be sound, clean, and free of mineral spots. Not more than an average of 1 in 500 splittings shall be vegetable stained. They shall be split to the specified thickness without thick edges. The edges shall be clean cut.
A....	Book form (1).. Loose with powder (2)....	6 up to 10 3 up to 6	1-1/2 1	.006 to .009 incl.	
B-1..	Book form (1).. Loose with powder (2)....	3 up to 6 2 up to 3	1 7/8	.006 to .009 incl.	
B-2..	Book form (1).. Loose with powder (2)....	1-1/2 up to 3	7/8	.007 to .010 incl.	
C....	Loose with powder (2)....	1 up to 1-1/2	3/4	.007 to .010 incl.	(2) Same as (1) except that the edges may be slightly irregular in shape. Not more than 5 percent of the splittings shall be slightly weathered or vegetable stained. None of the splittings shall have mineral stains.
D....	Loose (2).....	At least 70 percent shall be 1 up to 1-1/2. The balance shall pass over a screen having 3/4-inch square openings.	-	.007 to .010 incl.	
E....	Loose (2).....	At least 50 percent shall be 1 up to 1-1/2. The balance shall pass over a screen having 5/8-inch square openings.	-	.007 to .011 incl.	
F....	Loose (3).....	At least 80 percent shall have a minimum area of 3/4 sq. in. and shall pass over a screen having 5/8-inch square openings.	-	.007 to .011 incl.	(3) Splittings shall be sound and clean. They shall be split to the specified thickness. Not more than 7-1/2 percent of the splittings shall be slightly weathered or vegetable stained. None of the splittings shall have mineral stains.

^{1/} This classification is reproduced from American Society for Testing Materials Specification D 351-53T as adapted from Publication No. ME1-1952, Standards for Manufactured Electrical Mica, National Electrical Manufacturers Association.

^{2/} The numbers in parentheses refer to the correspondingly numbered remarks.

^{3/} "Up to" means "not including." Splittings shall not be all of the minimum size, but shall contain a fair proportion of sizes throughout the range specified. The size areas specified do not refer to the total area but to the rectangular size that each grade shall produce. For example, Grade A should be large enough to provide rectangular pieces measuring 1-1/2 by 2, 2 by 2, 2 by 2-1/3, ... etc., inches.

Qualifying

The quality of natural muscovite sheet mica usually is qualified visually. Interpretation of visual standards depends solely on the human eye and personal judgment and may vary from one observer to another. Visual classification is based upon the relative quantity of visible inclusions, such as air bubbles, stains, etc., and of structural imperfections contained in a piece of mica. Clear mica, which is hard, uniform in color, nearly flat, and free from all stains and other defects is the finest quality of mica. Increasing quantities of visual defects in the mica lowers the quality. In accordance with ASTM Specifications D 351-53T, based on the Bengal India system and shown in table 3, block mica falls into 11 quality groups, ranging from the poorest, Densely Stained, to the best, Clear. A verbal description for each of the 11 qualities, quoted from ASTM D 351-53T, is as follows:

V-1, Clear. - Hard, of uniform color, flat, free from all stains and foreign inclusions, waves, cracks, buckles, and other similar defects.

V-2, Clear and Slightly Stained. - Hard, of uniform color, fairly flat, free from all vegetable and mineral stains, cracks, buckles, and other similar defects and of foreign inclusions, except for a few tiny air inclusions is not more than one-fourth of the usable area.

V-3, Fair Stained. - Hard, of uniform color, free from all vegetable and mineral stains, cracks, buckles and other similar defects and of foreign inclusions, except may be slightly wavy and may contain slight air inclusions in not more than one-half of the usable area.

V-4, Good Stained. - Hard, free from vegetable or mineral stains, cracks, buckles, and other similar defects and of foreign inclusions, except may be somewhat wavy but not rippled and may contain medium air inclusions in not more than two-thirds of the usable area but may not have heavily concentrated air inclusions in any of the usable area.

V-5, Stained A. - Hard, free from cracks and other similar defects and foreign inclusions, except may be wavy with slight buckles and may contain medium vegetable stains, and the entire area may have air inclusions if not heavily concentrated.

V-6, Stained B. - Hard, free from cracks and other similar defects and foreign inclusions, except may be wavy and slightly buckled and may contain heavy air inclusions, medium vegetable, clay, and mineral stains.

V-7, Heavily Stained. - Hard, free from cracks or other similar defects and foreign inclusions, except may be wavy and buckled and may contain heavy air inclusions, heavy vegetable and medium mineral stains.

V-8, Black Dotted. - Same as Heavily Stained, except may contain black dots.

V-9, Black Spotted. - Hard, free of cracks or similar defects and foreign inclusions, except may be medium wavy and contain slight buckles and vegetable stains, black- or red-spotted mineral stains, and heavy air inclusions.

V-10, Black Stained. - V-9 quality, except may be soft and have black lines and/or short red bars or connected stains.

V-11, Densely Stained. - Soft, and may contain all heavy stains and inclusions and other defects, heavy waves, cracks, and buckles.

TABLE 3. - Quality classification of muscovite block mica 0.007-inch minimum thickness, based on visual properties^{1/}

ASTM visual quality classification	Clear-uniform ^b	Air inclusions				Light dots (mineral)	Smokey stains	Black stains (mineral) ^g	Black stains (mineral) ^e	Red stains (mineral) ^e	Green stains (vegetable type) ^f	Clay stains	Waviness				Hardness		Stones	Buckles	Reeves	Ridges	Tears	Cracks	Hairlines	Wedge	Tangle sheet	Herringbones	Ribbonded or ruled
		Very slight ^a	Slight ^b	Medium ^c	Heavy ^d								Nearly flat	Slight	Medium	Heavy	Hard	Soft											
V-1, clear.....	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-2, clear and slightly stained....	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-3, fair stained	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-4, Good stained	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-5, stained A	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-6, stained B	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-7, heavy stained ...	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-8, black dotted	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-9, black spotted ...	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-10, black stained....	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V-11, densely stained.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Symbols:

✓ - Permissible.

x - Not permissible.

S - Permissible only if specified.

^aFew and tiny in 1/4 of useable area.

^bIn 1/2 useable area.

^cIn 2/3 useable area.

^dUniformly distributed.

^eLight.

^fMedium.

^gHeavy.

^hCrystallographic discoloration is permitted to a limited extent in V-4 Good Stained quality. It is not permitted in qualities higher than V-4 Good Stained. In qualities below V-4 Good Stained it is permitted without limit.

Note 1. - The visual properties of block mica usually are judged under the following light conditions:

For stains and inclusions. - Transmitted daylight or equivalent.

For air inclusions. - Reflected daylight or equivalent.

For waves, buckles, ridges, etc. - Reflected daylight or equivalent where distortion of parallel and vertical lines of reflected image such as a window frame can be judged.

Note 2. - The hardness or mechanical properties of block mica are usually judged by a sharp, clear ring when mica is dropped on a hard surface.

Note 3. - Muscovite mica occurs in various colors which are more pronounced the thicker the block. Some typical colors are ruby, white, light green, rum, etc.

Note 4. - Cracks, tears, stones, or pin holes are judged by transmitted daylight or equivalent.

Note 5. - Rigidity is judged by the relative stiffness when flexing with the fingers.

^{1/} Source - American Society for Testing Materials.

Muscovite film mica is classified into three quality designations. First-quality film is equivalent in visual quality to Fair Stained block mica. Second quality is comparable to mica split from Good Stained block mica, while Third quality is equivalent to Stained quality block.

American Society for Testing Materials is preparing standard mica samples as an aid for a more uniform quality classification. A committee has agreed upon the samples and is attempting to eliminate duplication and minimize the number of specimens in each quality category. After the commingled samples are completed, they will be sent to ASTM headquarters at Philadelphia, Pa., and will be available for comparison. ASTM also is investigating costs and means of supplying duplicate sets.

Much foreign block and film mica is sold to industry according to quality groups that deviate somewhat from the quality nomenclature of ASTM. The prime difference between respective qualities is that a greater percentage of defects can be present than are permitted by ASTM specifications. While this usually is referred to as a commercial quality system, it has no exact standard except that the quality groups are based on ASTM specifications and respective qualities will vary from company to company.

The small domestic miner usually does not have the experience to appraise the mica for quality in accordance with ASTM standards. It has been customary in the United States during normal times for the miner to sell thumb-trimmed or half-trimmed block mica and qualify an entire lot of mica in a rough manner. Domestic block mica, including punch mica, is classified into two primary groups - Clear and Stained. Clear mica is subdivided into No. 1, No. 2, and No. 2 inferior. Black-Stained and Spotted mica is known as No. 3, electric, or stained. An approximate comparison between the domestic quality classification and ASTM standards is as follows:

<u>Domestic</u>	<u>ASTM</u>
No. 1	{ Clear, and Clear and Slightly Stained Fair Stained
No. 2	Good Stained
No. 2 inferior	{ Stained Heavy Stained
No. 3 (electric or stained)	{ Black Spotted Black Stained

A miner usually can sell sheet mica to industry without qualifying or grading the mica by selling it as mine-run mica. Many of the lots of domestic sheet mica sold to industry are of such small quantity that it is not worthwhile for the miner to classify the mica.

In recent years, attention has been given to classifying mica in terms of its electrical properties. The American Society for Testing Materials has adopted standard methods for testing the dielectric strength, power factor, and electrical conductivity of mica, as outlined in ASTM Designation D 748-52T. Natural block and film mica based upon its "Q" value or power factor can be divided into three groups. Group E-1 has a minimum Q value of 2,500 at 1 megacycle; E-2, a minimum of 1,500; and E-3, a minimum of 200. The Q value is the reciprocal of the power factor, which is a measure, expressed in percent, of electrical energy loss. A more conclusive

classification, using the electrical ratings, physical properties, and structural imperfections, in accordance with ASTM D 748-52T, divides block and film mica into classes C-1, C-2, and C-3. Class C-1 block and film mica has the highest Q value, a minimum of 2,500 at 1 megacycle (E-1 rating). Mica in this class is usable in all types of silver and foil electrode molded and clamped capacitors, including those used in high-stability tuned circuits, and high-current radio frequency transmitter circuits. Class C-2 mica has a minimum Q value of 1,500 and can be used in all silver and foil electrode, molded and clamped unit capacitors. However, some of the capacitors made from C-2 block and film mica may show a higher temperature rise for transmitter use than similar capacitors made with C-1 mica. Lowest Q value mica (minimum 200) falls in Class C-3 and is applicable in foil electrode molded and clamped capacitors where high stability and low-temperature coefficient are not required.

Suffix letters are used after the class designation to indicate the degree of air inclusions and waviness. Thus, a mica classed as C-1-BA would be of the highest electrical quality (C-1) with medium air inclusions (B) and flat to slightly wavy (A) (table 4). Class C-1-AA is equivalent to Fair Stained block or First quality film; C-1-BB, Good Stained block or Second quality film; and C-1-CC, Stained block and Third quality film.

Included in the test methods of Specification D 748-52T is a spark coil test for determining electrical conductivity of the mica. Certain mineral inclusions, particularly iron oxides, increase the conductivity and make the mica less desirable. Electrical conductivity in spotted and stained areas is revealed when the high-voltage spark glows.

Classification by electrical properties supplements the visual inspection system but does not eliminate mica containing some visual imperfections and inclusions if the mica passes the electrical requirements for conductivity and "Q." It has been found that sizable quantities rejected solely on the basis of visual classification are usable when tested by the "Q" meter and spark coil. Although this could result in a saving of mica, industry has been reluctant to replace visual inspection with electrical testing because of the economic factors involved in the segregation and testing of a large quantity of low-quality mica to obtain the relatively small quantity that may be found usable.

Color

Sheet mica also is classified according to color. Mica occurs in many colors, ranging from green through shades of green and brown to pinkish buff and drab. The Federal Geological Survey has arranged muscovite mica into seven main color categories and three commercial groups, as shown below:

<u>Main color categories</u>		<u>Commercial groups</u>
Pinkish buff and drab	}	Ruby
Cinnamon brown		
Brown		
Brownish olive	}	Rum
Yellowish olive		
Yellowish green	}	Green
Green		

TABLE 4. - Electrical, physical, and visual quality requirements of natural block and film mica for use in capacitors

	Class C-1	Class C-2	Class C-3
Electrical properties:			
Conductivity ⁸	None	None	None
Q value or power factor at 1 megacycle	E-1 ^a	E-2 ^a	E-3 ^a
Dielectric strength, v. per mil {average	1,000	1,000	1,000
at 60 cycles per sec., min., {single	850	850	850
Dielectric constant	b	b	b
Physical properties:			
Weight loss on heating (5 min. at 600° C.) max., percent	0.2	0.2	
Thickness uniformity (mica films) ^c	Best	Best	Intermediate
Temperature coefficient of capacitance and retrace	d	d	d
Visual qualities:			
Air inclusions ^e {A	None to slight	None to slight	None to slight
{B	Medium	Medium	Medium
{C	Medium to heavy	Medium to heavy	Medium to heavy
Waves ^f {B	Flat to slight	Flat to slight	Flat to slight
{C	Medium	Medium	Medium
Cracks	Medium to heavy	Medium to heavy	Medium to heavy
Tears	None	None	None
Pin holes	do.	do.	Do.
Stones	do.	do.	Do.
Buckles	do.	do.	Do.
Ridges	do.	do.	Do.

^aThe Q value or power factor ($Q = \frac{1}{\text{power factor}}$) of block mica or mica films suitable for use in

capacitors shall fall within the 3 electrical quality groups, based on end-use requirements, designated E-1 Special, E-1, E-2, or E-3. These quality groups shall conform to the Q or power factor values prescribed in Table III of ASTM D 748-52T or the corresponding scale readings of the vacuum-tube voltmeter when tested by the rapid, direct-reading method described in Appendix I, of ASTM D 748-52T.

^bAs the dielectric constant of natural block mica suitable for use in capacitors is fairly uniform, no specified requirement is needed.

^cUntil definite values can be specified, the permissible amounts of such defects shall be agreed upon by the purchaser and the manufacturer.

^dIt has been found that the temperature coefficient of capacitance and retrace of capacitors made with Classes C-1, C-2, and C-3 mica depend more on such factors as electrical and mechanical design and manufacturing technique than any differences that may be attributed to the mica itself.

^eThe amount of air inclusions shall not exceed the specified limits for each subclass as judged by the photographic reference standards⁵ shown in figs. 1 to 3 of ASTM D 748-52T. The permissible amount of air inclusions shall be stated by suffixing the letter A, B, or C, as the case may be, to the required electrical quality class.

^fUntil definite values can be specified, the permissible amount of waves, buckles, and ridges shall be agreed upon by the purchaser and the manufacturer. The permissible amount of waves shall be stated by suffixing the letter A, B, or C, as the case may be, to the letter denoting the amount of permissible air inclusions, for example: Class C1 B A block mica or mica films denotes:

C-1	B	A
Best electrical quality	Medium air inclusions	Flat to slight waves

⁸This applies to the conductivity of visible spots and stains only and excludes "air stains or air inclusions."

1/ American Society for Testing Materials.

The National Bureau of Standards has established two color groups, namely ruby and nonruby. In the laboratory, hue and lightness indices are used to determine the color of the mica. Despite the many variables that effect color, industry has a definite idea of what is acceptable as ruby mica. An experienced inspector becomes familiar with the family of colors that falls in each group. Mica having a ruby color is classed as ruby, and mica appearing green or brownish, disregarding variations such as air or mineral inclusions and stained areas, is classed as nonruby. Mica for the National Stockpile is purchased on the Bureau of Standards color classification.

[Ruby mica is the preferred color because its "Q" factor is fairly constant and it splits easily. Industry is reluctant to use nonruby as a substitute for ruby mica in electronic products. Nonruby has a tendency to be brittle, and its "Q" factor varies considerably and often is undesirably high. Normally, nonruby is accepted only if it passes the visual and electrical tests. For ordinary electrical uses, color is of little significance.]

MARKETING

Production and Consumption

The United States is the world's largest consumer of muscovite sheet mica, but only a small part of the United States requirements is produced domestically. High labor costs in the United States and the large labor factor required to mine and process sheet mica have restricted the domestic mica industry. Historically, domestic production has been mainly punch mica. Only in times of emergency through Government subsidization have sizable quantities of sheet mica been produced domestically. Crude sheet mica production in 1953 totaled 667,241 pounds of punch mica valued at \$98,010 and 182,153 pounds of sheet mica larger than punch valued at \$2,055,574. North Carolina was the largest producing State for sheet mica in 1953, supplying 73 percent of the total domestic output. The remaining production came from the following States, arranged in order of importance by quantity produced: New Hampshire, Connecticut, Maine, Idaho, Virginia, Georgia, South Dakota, and Alabama. Consumption of block and film mica cut or stamped to dimension by domestic fabricators totaled 4,305,599 pounds, of which only 10 percent was from domestic mines (97 percent of this was punch mica). Distribution of consumption of block and film mica in 1953 for end-product use by quality is given in table 5. Consumption of muscovite splittings totaled 9,443,364 pounds. The electronic and electrical industries, which are so essential to the highly mechanized way of life in the United States, must rely on foreign sources for the higher quality sheet mica. India has been the principal source of muscovite sheet (block, film, and splittings). In recent years, Brazil has been an important exporter of block mica to the United States. Smaller quantities of muscovite block mica have come from Angola, Argentina, Canada, Northern and Southern Rhodesia, and Tanganyika.

— Uses

Sheet mica, as single pieces split from crystals or as composite pieces in a built-up form, is an important material to the electronic and electrical industries. Block mica is used in manufacturing transmitting and receiving tubes, high-temperature steam gage glass, diaphragms, compasses, and as an insulator in electrical equipment (table 5). In the electronic field, most of the block mica is consumed as bridges and spacers in radio and television tubes. Usually more Stained quality block is used for tube manufacture than any other quality. Lower qualities of block mica, including punch mica, are used mainly as electrical insulators in household appliances such as electric irons, toasters, and water heaters; in incandescent lamps; fuse plugs; and other electrical appliances.

TABLE 5. - Fabrication of muscovite ruby and nonruby block and film mica, by quality and end-product use in the United States, 1953, in pounds

Variety, form, and quality	Electronic uses			Nonelectronic uses			Grand total
	Capacitors	Tubes	Other	Total electronic	Gage glass and diaphragms	Other	Total non-electronic
Muscovite:							
Block:							
Good Stained or better..	1,377	126,339	4,354	132,070	7,134	10,597	17,731
Stained	9,282	1,956,917	32,043	1,998,242	1,706	150,031	151,737
Lower than Stained	314	540,787	32,665	573,766	1,246	1/1,184,424	1,185,670
Total	10,973	2,624,043	69,062	2,704,078	10,086	1/1,345,052	1,355,138
Film:							
First	51,954	8	-	51,962	-	2	2
Second	181,793	-	176	181,969	-	321	321
Other	12,129	-	-	12,129	-	-	-
Total	245,876	8	176	246,060	-	323	323
Block and film:							
Good Stained or better ^{2/} ..	235,124	126,347	4,530	366,001	7,134	10,920	18,054
Stained ^{3/}	21,411	1,956,917	32,043	2,010,371	1,706	150,031	151,737
Lower than Stained	314	540,787	32,665	573,766	1,246	1,184,424	1,185,670
Total	256,849	2,624,051	69,238	2,950,138	10,086	1,345,375	1,355,461

1/ Includes punch mica.

2/ Includes first and second quality film.

3/ Includes other quality film.

Film mica is used in capacitors that hold or store an electrical charge. Mica is useful in capacitors because it can be split into thin sheets, has a high dielectric constant and low power factor, is resistant to high temperatures, and can be fabricated easily. Certain capacitors, especially those used in high voltages and high frequencies can be made only from mica. Film mica for capacitors must be fairly flat, must split to close tolerances and be of the higher qualities (Stained or better).

Mica splittings are used in manufacturing built-up mica by heating, pressing, and trimming alternate layers of splittings and a binder (shellac, alkyl, or silicone resin). Products cut or stamped from sheets of built-up mica are used mainly as an insulating material in electric motors, generators, and transformers.

In peacetime, the emphasis is placed on mica usable in radio and television tubes, household appliances, heavy electrical equipment, and, to a lesser degree, capacitors. Civilian consumption requires large quantities of the lower quality sheet mica and demand for the highest qualities is not excessive. However, in times of emergency and stockpiling, demand for high-quality mica suitable for essential military applications increases tremendously. From all indications, sheet mica, especially of the higher qualities, will be in high demand for many years to come.

Buyers of Sheet Mica

Commercial buyers of block and film mica are shown in the accompanying list of mica fabricators (table 6). These buyers usually purchase both domestic and foreign mica, but in the past few years only the fabricators in North Carolina and Virginia have purchased domestic mica. Companies purchasing mica splittings are shown in the list of built-up mica producers (table 7). Importers of sheet mica are listed in table 8.

Government Mica Programs

Strategic muscovite block and film mica, according to the present concept, is ruby and nonruby block, Good Stained or better qualities, grade No. 6 and larger; ruby Stained quality, grade No. 6 and larger; and ruby and nonruby film, First and Second qualities, grade No. 4 and smaller. Strategic muscovite splittings are splittings in the book and loose dusted form, grade No. 6 and larger, and loose packed form, No. 6. Pursuant to Section 2(a) of Public Law 520, 79th Congress, mica block, film, and splittings were placed on the list of strategic and critical materials to be acquired for the National Stockpile. The Government has two mica programs - one for purchasing domestic and foreign sheet mica and the other for assisting domestic mica exploration.

TABLE 6. - Fabricators of block and film mica

Aerovox Division, Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.
American Mica Insulation Co., 235 Parker Ave., Manasquan, N. J.
American Mica Products Co., 17 East 48th St., New York 17, N. Y.
Asheville Mica Co., P. O. Box 318, Newport News, Va.
The B G Corp., 321 Broad Ave., Ridgefield, N. J.
Carpenter & Phillips Mica Co., P. O. Box 657, Spruce Pine, N. C.
Cornel-Dublier Electric Corp., 55 Cromwell St., Providence 7, R. I.
Diamond Power Speciality Corp., P. O. Box 415, Lancaster, Ohio
Farnam Mfg. Co., Inc., Sweeten Creek Rd., Asheville, N. C.
Ford Radio & Mica Corp., 536 - 63d St., Brooklyn 20, N. Y.
General Electric Co., 1 River Road, Schenectady 5, N. Y.
Huse-Liberty Mica Co., 171 Camden St., Boston, Mass.
Industrial Mica Corp., 223 South Van Brunt St., Englewood, N. J.
Mica Fabricating Co., 53 Central Ave., Rochelle Park, N. J.
Mica Insulator Co., 757 Broadway, Schenectady 5, N. Y.
Micacraft Products, Inc., 701 McCarter Highway, Newark 5, N. J.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn 37, N. Y.
Perfection Mica Co., 20 North Wacker Drive, Chicago, Ill.
Radio Corporation of America, Tube Div., Camden 2, N. J.
Reliance Mica Co., 341 - 39th St., Brooklyn, N. Y.
Sangamo Electric Co., Box 7, Marion, Ill.
Sprague Electric Co., Marshall St., North Adams, Mass.
Spruce Pine Mica Co. & Mayland Mfg. Co., Spruce Pine, N. C.
Sylvania Electric Products, Inc., Smethport, Pa.
The Tar Heel Mica Co., Inc., Plumtree, N. C.
Victory Mica Mfg. Co., Inc., 1313 - 39th St., Brooklyn 18, N. Y.
Vulcan Electric Co., Div. of Consolidated Electric Lamp Co., 88 Holton St., Danvers, Mass.
Western Electric Co., Inc., 195 Broadway, New York 7, N. Y.

TABLE 7. - Producers of built-up mica

(Consumers of mica splittings)

Allis-Chalmers Mfg. Co., Box 512, Milwaukee 1, Wis.
American Electrical Heater Co., 6110 Cass Ave., Detroit, Mich.
Cleveland Mica Co., 1360 Hird St., Lakewood, Ohio
Continental-Diamond Fibre Co., Valparaiso, Ind.
General Electric Co., 920 Western Ave., West Lynn 3, Mass.
General Electric Co., 1 River Road, Schenectady, N. Y.
General Electric Co., 2901 East Lake Road, Erie, Pa.
The Macallen Co., Bay Road, Newmarket, N. H.
Mica Company of Canada, 900 Jefferson Ave., Newport News, Va.
Mica Insulator Co., 757 Broadway, Schenectady 5, N. Y.
National Electric Coil Co., Columbus 16, Ohio
New England Mica Co., Inc., 66 Woerd Ave., Waltham, Mass.
The Tar Heel Mica Co., Inc., Plumtree, N. C.
Westinghouse Electric Corp., 306 Fourth Ave., Pittsburgh 30, Pa.

TABLE 8. - Importers of sheet mica

American Mica Insulation Co., 235 Parker Ave., Manasquan, N. J.
Ameritex Development Corp., 37 Wall St., New York, N. Y.
Asheville-Schoonmaker Mica Co., Inc., 62 Worth St., New York, N. Y.
Associated Commodity Corp., 150 Broadway, New York 38, N. Y.
Blanchard Mica, Inc., 2315 Broadway, New York 24, N. Y.
BMT Commodity Corp., 233 Broadway, New York 7, N. Y.
Brand Dielectrics, Inc., 57 North St., Willimantic, Conn.
Brown, Alfred D. Associates, Inc., 59 Pearl St., New York 4, N. Y.
Buck, Leonard J., Inc., 1 Newark Ave., Jersey City 2, N. J.
Crystals, S. A., 214 East 18th St., New York 3, N. Y.
Federal Export & Import Cos., 92 Liberty St., New York 6, N. Y.
Ferrotrader (Canada), Inc., 265 Craig St., Montreal, Quebec
Frazar & Co., Inc., 50 Church St., New York 7, N. Y.
Ford Radio & Mica Corp., 536 - 63d St., Brooklyn 20, N. Y.
Garneau Mica Co., Inc., 11 Park Place, New York, N. Y.
Gillespie-Rogers-Pyatt Co., Inc., 75 West St., New York 6, N. Y.
Haber's Export Agencies, Inc., 45 N. Broad St., Ridgewood, N. J.
Hal Dalphin & Co., 880 Bergen Ave., Jersey City 7, N. J.
The India Mica Co., 105-37 - 86th St., Ozone Park 17, New York, N. Y.
Inter-Ocean Trade Co., 48 West 48th St., New York 36, N. Y.
Lager, Andrew & Co., Inc., 150 Broadway, New York 38, N. Y.
Madagascar Graphite & Mica Co., 92 Liberty St., New York 6, N. Y.
Manchard Trading Corp., 2315 Broadway, New York 24, N. Y.
Minerals & Insulation Co., 53 Central Ave., Rochelle Park, N. J.
Munsell, Eugene & Co., 34 Exchange Place, Jersey City, N. J.
National & Foreign Trade Corp., 38 Pearl St., New York, N. Y.
The Otto Gerda Co., 82 Wall St., New York 5, N. Y.
Paquet, M. & Co., Inc., 17 Battery Place, New York 4, N. Y.
Pitts, F. D., Co., 85 Chestnut Hill Road, Newton 67, Mass.
Rector Mineral Trading Corp., 551 Fifth Ave., New York 17, N. Y.
Schwab Brothers Corp., 102 Maiden Lane, New York 5, N. Y.
Sigbert Loeb, 120 Libert St., New York 6, N. Y.
Silvio Gaguine & Co., 154 Nassau St., New York City, N. Y.
Strygler, H. S., & Co., 665 Fifth Ave., New York 22, N. Y.
Suhr & Budelman, Inc., 97 State St., Westbury, Long Island, N. Y.
Superior Mica & Mineral Supply Corp., 174 North Franklin St., Hempstead, Long Island, N. Y.
Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.
Trans American Mercantile Corp., 120 West 42d St., New York 36, N. Y.
United Mineral & Chemical Corp., 16 Hudson St., New York 13, N. Y.
Western Hemisphere Raw Materials Co., 1 Newark Ave., Jersey City, N. J.
Whittaker, Clark & Daniels, Inc., 260 West Broadway, New York 13, N. Y.

In 1952, the United States Government authorized, through General Services Administration (GSA), purchasing programs for sheet mica mined within the United States. Program A is for the purchase of muscovite ruby and nonruby block and film mica and Program B for ruby and nonruby hand-cobbed mica. Both programs are to be in effect until June 30, 1957 or when the total block, film, and hand-cobbed mica delivered to and accepted by the Government reaches the equivalent of 25,000 short tons of hand-cobbed mica (90 pounds of block and film mica are equivalent to 1 ton of hand-cobbed mica). All muscovite block and film mica purchased under Program A must conform to the appropriate requirements for grade, quality, and thickness in accordance with ASTM Specifications D 351, latest revision as of date of acceptance

for each lot. Nonruby block and film mica of Good Stained or better qualities also must meet requirements for Class C-1-BB of ASTM Specifications D 748, latest revision as of date of acceptance of each lot. Block and film mica is purchased in three quality groups - Good Stained or better, Stained, and Heavy Stained - and in three grade groups - Nos. 5-1/2 and 6, Nos. 4 and 5, and Nos. 3 and larger. All Good Stained or better block and film must be full-trimmed, but Stained and Heavy Stained is accepted as full-trimmed or half-trimmed. Hand-cobbed mica purchased under Program B must yield at least 40.5 pounds of full-trimmed block or film mica, Stained or better qualities, per short ton, when processed by the depot. Block and film mica processed from hand-cobbed mica must conform to the requirements of Program A regarding grade, quality, and thickness.

Purchasing depots are at Spruce Pine, N. C.; Franklin, N. H.; and Custer, S. Dak. Mica should be delivered f. o. b. the nearest depot, with each lot containing either ruby or nonruby mica. Mixed lots are not accepted. Any person wishing to participate in either program should notify the Regional Director, GSA, having jurisdiction over the nearest depot or the superintendent of the depot. Such notice should state that the applicant has read the mica regulations (Title 32A - National Defense, Appendix, Chapter XIV, General Services Administration, Mica Regulation: Purchase Programs for Domestic Mica), state he accepts the terms and conditions, and indicate the program in which he desires to participate. The superintendent of the respective depot will notify the participant of a delivery date. Each mica delivery is inspected at the depot, and any mica not conforming to the minimum requirements is rejected, with all costs except inspection cost being borne by the participant. Prices for domestic mica purchased by the Government under Program A are given in table 10.

The Government also purchases muscovite block and film mica produced in foreign countries. Ruby and nonruby block mica is purchased in the full-trimmed condition, Good Stained or better quality, grade 6 and larger. Ruby block also is accepted in the Stained quality under certain conditions with a proportionate quantity of ruby Good Stained or better qualities. Half-trimmed block is purchased only for ruby of qualities lower than Good Stained. Ruby and nonruby film are acceptable as full trimmed, First and Second qualities. Each lot of block and film mica must conform to National Stockpile Material Purchase Specifications P-32a-R (block) and P-32b-R (film). These specifications incorporate ASTM Specifications D 351 and D 748.

Nonruby block and film mica also must meet requirements for Class C-1-BB of ASTM Specification D 748.

The National Stockpile objective for muscovite splittings has been reached, and no new contracts have been issued since 1951.

Foreign mica usually is bought by the Government for delivery to a GSA warehouse through Federal Supply Service, 34 Exchange Place, Jersey City, N. J.

The encouragement of exploration of unknown or undeveloped sources of strategic mica through financial assistance was established as a function of Defense Minerals Exploration Administration in 1951. Under the program, the Government advances 75 percent of the approved costs of the mica exploration project, repayable from the net returns from any mineral produced as a result of the project within 10 years after certification of discovery or development. Applications for exploration assistance may be obtained from and filed with DMEA, Department of the Interior, Washington 25, D. C., or the nearest DMEA field executive office. If the application warrants a field examination, members of a DMEA field team (usually a Federal

Bureau of Mines mining engineer and Federal Geological Survey geologist) will examine the property to determine if an exploration project is justified. In the event an application is approved, the Government will enter into an exploration contract with the applicant.

Prices

Prices offered by fabricators for domestic sheet mica range from a few cents to over \$10 per pound. Quoted prices are nominal, and actual selling prices are determined by direct negotiation between buyer and seller after agreement as to quality and grade of particular lots. Prices in the North Carolina district in 1955 are shown in table 9. The range in price for each grade is caused by differences in quality, preparation, and exactness of grading.

Prices paid by the Government for domestic sheet mica under Program A are about 3 to 5 times the market price. Payment for each lot of ruby and nonruby block and film mica containing 18 percent or more Good Stained or better quality is made on the price schedule shown in table 10. Payment for any lot containing less than 18 percent Good Stained or better quality is made using the price schedule, table 10, with adjustments to account for proportions of lower quality mica.

TABLE 9. - Prices for various grades and qualities of sheet mica in North Carolina district, 1955, in dollars per pound

Grade (size)	Price per pound	
	Clear quality	Stained quality
Washer mica	\$0.06 - \$0.10	\$0.06 - \$0.10
Punch mica	.10 - .16	.10 - .16
1-1/2 x 2 inch	.70 - 1.60	-
2 x 2 inch	1.10 - 1.60	.70 - 1.10
2 x 3 inch	1.60 - 2.00	1.20 - 1.60
3 x 3 inch	1.80 - 2.30	1.40 - 1.80
3 x 4 inch	2.00 - 2.60	1.60 - 2.10
3 x 5 inch	2.60 - 3.00	1.80 - 2.70
4 x 6 inch	2.75 - 4.00	2.00 - 3.00
6 x 8 inch	4.00 - 8.00	2.25 - 3.50
8 x 10 inch	6.00 - 13.00	3.00 - 4.00

TABLE 10. - Domestic mica purchasing program (GSA) prices per pound, ruby and nonruby block and film mica

Grades	Qualities				
	Full-trimmed			Half-trimmed	
	Good Stained or better	Stained	Heavy Stained	Stained	Heavy Stained
<u>Ruby</u>					
No. 3 and larger.....	\$70.00	\$18.00	\$13.00	\$12.00	\$8.00
No. 4 and No. 5	40.00	8.00	6.00	5.00	4.00
No. 5-1/2 and No. 6	15.00	5.00	3.00	3.00	2.00
<u>Nonruby</u>					
No. 3 and larger	70.00	14.40	10.40	9.60	6.40
No. 4 and No. 5	40.00	6.40	4.80	4.00	3.20
No. 5-1/2 and No. 6	15.00	4.00	2.40	2.40	1.60

Government prices paid for ruby or nonruby hand-cobbed mica under Program B are \$600 per short ton and \$540 per short ton, respectively, based on a yield of 16.2 pounds of Good Stained or better qualities and 24.3 pounds of Stained quality block or film mica per short ton. If the actual yield exceeds the preliminary estimate, the participant will be paid the difference, and if the yield is less than preliminary estimates, the amount of overpayment must be repaid to the Government.